Pest Notes

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Detecting Penetration of Stored Product Pests

PCT-Online
Amanda Paskiet

With consumers' growing desire to buy food in bulk sizes comes a growing concern for the pest control industry: stored product pests.

"The biggest problem with these huge packages is that people don't use the food up fast enough to prevent pests. Those insects cause losses to both the consumer and the manufacturer," said Dr. Linda Mason, an entomologist at Purdue University. Mason directs the pest management program in the Center for Urban and Industrial Pest Management at the university.

Mason believes that detecting food penetration is a skill every PCO should hone, especially since people have a lower tolerance for insects today than they did when she was young and would help her grandmother skim insects off the top of a pot of boiling rice.

At first, insects in our food was simply a sanitation problem. Then we changed the way the package was designed and developed chemicals we could use to keep insects away," said Mason, who said that she now spends a good deal of her time discussing ways to use less of those pesticides with the Environmental Protection Agency. "People don't want pesticides near their food anymore than they want insects."

How Do they Get There?

According to Mason, insects get inside food packages

(Continued on page 2)

Stalking Stinging Insects

PCT-Online
Curt Colwell

Accounts that involve bee and wasp control can be beneficial for PCOs…as long as they don't get stung. They say there are two sides to every story — and stinging insects are no exception. Bees and wasps may be man's best friend among insects, yet these highly beneficial insects also cause problems that can be life threatening.

Take a good look at your dinner tonight. It's a good bet that most of what you are eating is compliments of our friends, the bees. Bees and other insects pollinate many fruit and vegetable crops. Without them, our food would be pretty boring.

Bees and wasps are beneficial in other ways as well. They produce honey and beeswax, both of which provide hobbies for some people. Wasps also help control pests such as caterpillars, flies and spiders.

Of course, these insects are also beneficial for pest control operators. Many profitable dollars are derived from the bad side of the bee and wasp story. The bad side includes those unsightly mud and paper nests plastered on the sides of houses. But more important is the way bees and wasps defend themselves. Every year in the United States 50 to 100 people die from bee and wasp stings. In most cases, people will die within an hour if they have an allergic reaction to the venom. Fortunately, fewer than one in 100 people are allergic to bee and wasp venom.

(Continued on Page 2)

(Stored Product Pests…Continued from page 1)

two ways: either they fell in during the manufacturing process, or they found their way in from the outside.

"If an insect has gotten in from the outside, it either got in because they're physically able to by making a hole in the packaging or the consumer has not properly stored the package or closed it all the way," said Mason.

The package in which the food comes may be an effective weapon against insect infestation, however, Mason said a package is only as good as its design. "As soon as that package is opened, any defense against pests is broken," Mason said. "Think of the cereal you had for breakfast. When you put it away, all you do is roll that plastic bag down into the box."

With the package opened and insects found inside the package, the key element for PCOs becomes how to detect whether the insects penetrated the box from the inside or the outside. Insects leave several clues for PCOs who need to know how the insect infested the food.

The insect exited the package if:

- There is a clean, round edge on the outside
- The hole is shaped like a funnel. The larger end is the point of entry and the smaller end is the point of exit
- The side the insect exited from is smooth and free from bite marks
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The insect entered the package if:

- The edges of the hole are frayed and choppy
- There are "test" bite marks where the insect searched for weak spots in the material

Who's At Fault?

Mason said that proper detection of the insect-infested package by a PCO can uncover who was at fault: the manufacturer, the retail store or the consumer.

"PCOs have played an important role in lawsuits dealing with stored product pests," said Mason. "It's a vital skill to any PCO."

(Stinging Insects…Continued from page 1)

Unfortunately, almost all bees and wasps we encounter, including all of the species mentioned here, are capable of stinging. The stinger is a modification of the insect's egg-laying tube, or ovipositor. Now, if you think only females can sting, you are correct. But there's no use wondering whether that bee or wasp is a stinger-equipped female or a harmless male. The fact is that almost 99% of wasps and bees that people come in contact with are female. Just assume that any wasp or bee can sting.

A SOCIAL LIFESTYLE? Among the many distinctive features of bees and wasps are their living arrangements. Some lead a solitary lifestyle while others live together in groups. We call those that live together "social" insects and this group includes ants, termites and some bees and wasps.

Knowing whether a particular wasp or bee is solitary or social is the key to understanding its behavior. For example, you are much more likely to be stung by a social bee or wasp rather than a solitary one because you are more likely to encounter a social wasp. These social insects are generally not as secretive and anti-social about where they build their nests. Also, social wasps sting not only to protect themselves, but also to protect an entire colony, including family members. That's right — all of the wasps or bees in a colony are related. That is why these insects cooperate with one another.

Each individual in a wasp or bee colony belongs to a specific caste. Social insects are defined by the "Three Cs": colonies, cooperation and castes.

Yellowjackets are social wasps. Like other social wasps, they build nests of paper by chewing wood and mixing it with saliva. You get wasp calls in the fall because there are simply more yellowjackets late in the season. In addition, yellowjacket food supplies become scarce. The wasps typically forage for insects to feed their larvae. When these insects start dying from the cold or seek shelter in which to spend the winter, yellowjackets are forced to look for new food sources. In the fall there are more yellowjackets and that is the time of year that they're more aggressively scavenging for food associated with humans.

WHAT'S IN SEASON? Now, let's look at the whole season in a typical social wasp or bee colony. In spring, a queen locates a suitable nesting site and builds a nest

(Continued on page 3)

(Stinging Insects…Continued from page 2)

She lays eggs and does all the chores that the workers will do later. Those chores include enlarging, cleaning and repairing the nest, defending the colony and finding food. For wasps, that food is usually insects and spiders. For bees, it is nectar and pollen from flowers.

When the first workers emerge from their pupal cocoons, they break out of the familiar hexagonal cells and take over the queen's colonial chores, all except laying eggs. Additional batches of workers are produced through the summer and the colony grows.

In most regions of the United States, all members of the colony will die as winter approaches, except a few females destined to become next year's queens. These various females seek shelter and warmth when temperatures grow cold, often ending up in various cracks and crevices in buildings. The ones that spend the winter in buildings may emerge well before springtime due to the artificial heat in these structures. It is these new queens that you suddenly see in February around your window or crawling sluggishly across the floor.

The life cycle described above is typical of social bees and wasps, although the honey bee life cycle is different. First, honey bee colonies are perennial — they survive winter and continue on indefinitely. They can do this despite cold temperatures because of the way their colonies are constructed and by special behaviors that allow them to survive inside the nest. In addition, honey bee colonies produce drones and new queens in spring and mating occurs at the same time.

PREVENTION. As with many other pests, exclusion is probably the best control method for stinging insects. Sealing exterior cracks and crevices helps prevent honey bees and yellowjackets from nesting inside structures. Applications of long-lasting dusts to wall voids, soffits and attic voids can provide additional protection.

Perhaps less can be done to thwart species such as paper wasps, mud daubers and bald-faced hornets that build nests *on* structures. In spring, frequent inspections of the building's exterior, along with attics and crawlspaces, can detect nests early before they grow and become more difficult to deal with. In the insects' early stages, insecticide use is unnecessary because the nests can simply be removed. But, surface applications of liquid residuals to likely nest sites (e.g., eaves and soffits) can help prevent nesting.

CONTROL. When attempting control of bees and wasps, especially the social species, PCOs should take every precaution to avoid being stung. About 75% of people who are frequently stung become "immune" to stings, having little or no reaction to them. But some, about 2%, develop allergic reactions to stings that can be dangerous or even life threatening. So, it's not a bad idea to have a bee sting kit handy. The kits are available by prescription and can prevent allergic reactions from becoming life threatening.

Allergies aside, another danger for the prospective bee and wasp specialist is the ladder used to reach the insects' nests. Falling off ladders is one of the most common accidents in pest control. Needless to say, the odds of injuries increase when you're perched on a ladder concentrating on not being stung by dozens of angry bees!

Another often overlooked but highly valuable precaution is the bee suit, which can prevent stings altogether. The suits can be purchased for around $100. At this price, can anyone serious about bee and wasp control afford NOT to have one?

Control of solitary bees and wasps, as well as social wasps, can be accomplished simply by removal of the nest or by application of residual insecticides directly to the nest.

Removal of bald-faced hornets' nests can also be effective, although survivors may rebuild them. If immediate removal isn't practical, punch a duster tip into the nest and apply dust to the interior and the entrance hole. A quick knockdown aerosol (e.g., those containing pyrethrins) can be used when first approaching the nest to avoid being stung by the sentries.

Quick knockdown is also recommended when working with yellowjacket nests, such as those in attics and crawlspaces. Again, once the guard workers are subdued with aerosol, dust can be applied into the nest.

Where bees or wasps are nesting in structural voids and entering the structure through exterior holes, cracks or crevices, dust or residual liquids should be applied into the openings. This alone may not be sufficient for complete control, as the nest may be several feet from the hole. A pressure duster or Actisol-type unit can be used to achieve greater penetration. It may also be necessary to drill and treat voids in walls, soffits and other areas.

(Continued on page 4)

(Stinging Insects…Continued from page 3)

Finally, there is the all-too-common problem of scavenging yellowjackets around food and trash at food processing plants and outdoor gatherings, such as picnics. Often nests cannot be located, as yellowjackets will forage up to 1,000 yards from the nest. Insecticide applications have generally not been useful in these situations. Fans and air doors, used to "blow away" the yellowjackets, are often impractical. Keeping trash cans and dumpsters tightly closed and regularly cleaned and emptied can help. Mass trapping has been employed with mixed results.

One problem with trapping has been finding a bait that attracts yellowjackets consistently. Recently, however, the USDA may have discovered a "universal" yellow-jacket bait, a byproduct of sugar consumption produced by bacteria and fungi. It is said to be highly attractive to many types of yellow-jackets, hornets and even some paper wasps.

CONCLUSION. As you can see, there's a solution for even the most difficult wasp and bee problems. Like so many other pests, control of stinging insects often depends on correctly identifying the insect and the problem, then employing the appropriate controls. Once again, the key to success is knowledge of the various wasp and bee species, of their identifying characteristics and behaviors, and of control methods. Wasp and bee control doesn't have to be difficult or dangerous. It can be a valuable part of any pest control business — for those who have the knowledge to make it so.

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Making A Difference

PCT-Online
Richard Kramer, W. Jay Nixon, Ronald S. Frazier

A recent study reveals that German cockroach population reduction can be accomplished despite the level of sanitation in an apartment, although when customers cooperate, reduction occurs much faster.

From March 1998 through January 1999, American Pest Management, Takoma Park, Md., evaluated four methods of reducing the risk of acute asthma attacks in inner-city housing occupants who are exposed to cockroach allergens. Apartments were monitored for German cockroaches and, as necessary, treated with Maxforce Cockroach Gel Bait containing hydramethylnon. This reduced-risk pest management strategy minimized the exposure of children to pesticides in the home environment and eliminated, to the maximum extent possible, one of the major sources of asthmatic antigens (German cockroaches).

Apartment housing suspected of having an active German cockroach infestation in most units and a reasonable expectation of cooperation was selected for the project. The majority of occupants were Hispanic and there were typically one to four people per apartment. Most of the apartments were designed as efficiencies, i.e., living room, kitchen, bathroom and large storage room next to the bathroom, typically used as a closet or additional sleeping space.

The apartment floors were wood parquet, except one that had wall-to-wall carpeting. The bathroom and kitchen floors were ceramic and vinyl tiles, respectively. Kitchen cabinets were metal or wood and there were many holes and cracks around the cabinets and n the walls to offer cockroaches abundant harborage. Heating was a hot water/radiator system. Several apartments had window air conditioners.

First Procedure. Thirty-eight apartments were surveyed (in a four-story building of 112 units) for German cockroaches by placing three sticky monitors (one behind the refrigerator, kitchen base cabinet and kitchen wall cabinet) in each unit. An inspection and collection of monitoring data was made 48 hours after monitors were placed. Criteria used to determine suitability for participation included:

- Live cockroaches and/or presence of cockroach droppings;
- Apartment size: either an efficiency, 1- or 2-bedroom;
- Absence of wall-to-wall carpeting;
- State of housekeeping, rated one to five (bad to excellent); and
- Perceived cooperation of tenant.

Second Procedure. Thirty-two apartments were selected for participation in the study. Eight apartments were placed in each of the following categories:

- Group A: baiting, cleaning and education;
- Group B: baiting and education;
- Group C: baiting only; and
- Group D: self-help baiting and education.

During the initial inspection, an English or Hispanic information sheet was left in each apartment

(Continued on page 5)

(Making a Difference…Continued from page 4)

indicating that monitors were placed and that the tenant would have an opportunity to participate in a pest management program.

Prior to initiating baiting and cleaning, swab and dust samples for cockroach antigen detection and quantification were collected from all the apartments included in the study.

• Four swab samples (kitchen and living room floors, kitchen base cabinet and living room wall) were taken using a cotton swab moistened with phosphate buffered saline. The sample area was about 4 inches by 4 inches. Samples were tested using a polyclonal antibody detection system.

• Two vacuum cleaner (kitchen floor and living room floor) samples (1 square meter area) were taken from each apartment and the samples were tested using a monoclonal antibody detection system.

Tenants in the apartments identified for cleaning removed all items from the kitchen cabinets and the kitchen area. The cabinets, areas behind the stove and refrigerator and the floors were cleaned using a variety of cleaning materials. Cleaning materials included 409 All-Purpose Cleaner for greasy surfaces; Clorox Clean-Up for counters, walls and cabinets; and a 10 percent bleach solution for floors. Cleaning of the eight units was repeated monthly.

Swab and dust samples were collected from the eight apartments in Group A after the initial cleaning and every 90 days until the study's completion.

A professional bilingual educator was employed to provide counseling on the purpose of the project, the importance of sanitation and cockroach control and procedures for self-help baiting. At the time of the face-to-face session, tenants were provided an English or Hispanic fact sheet that discussed the importance of cockroach control and the occupant's role in the process.

Each month all apartments in the study were visually inspected for cockroaches and housekeeping was evaluated. In addition to the visual inspection and housekeeping rating, at 90-day intervals sticky monitors, were placed out 24 hours prior to the service day and counts were made at the time of service.

Results. Cockroach data was collected during 10 consecutive months beginning in March 1998. The results of the sticky trap monitoring (GRM), visual inspections (GRV) and housekeeping ratings (HK) were recorded.

After the first 90 days, the most notable reductions in cockroach populations were achieved in Group A (baiting, cleaning and education) and B (baiting and education) apartments, 94 percent and 98 percent, respectively. The reductions in the Group C (baiting only) and D (self-help baiting and education) apartments were significantly less at 68 percent and 45 percent, respectively. At the conclusion of the study (300 days) the percent reduction in the cockroach populations in Group A to D apartments were 98 percent, 99 percent, 57 percent and 95 percent, respectively.

The initial average housekeeping ratings for Groups A to D apartments were 3.125, 3.0, 3.0 and 3.0, respectively. At the conclusion of the study the average housekeeping ratings for Group A to D apartments were 3.0, 2.43, 2.57 and 1.83, respectively.

The greatest amount of German cockroach debris (GCRD) extract as measured by polyclonal (swab) cockroach antigen tests (competitive inhibition ELISA) were detected consistently in the kitchen cabinets. There was significant variability in the GCRD values for the other sampling sites, i.e., kitchen floor, living room floor and living room wall, however the amount of detectable GCRD was significantly lower in these areas when compared to the kitchen cabinets, which had the greatest amount of German cockroach activity and debris. The pre- and post-cleaning samples also indicated a reduction in the amount of GCRD as the result of cleaning activity. This was most notable in the kitchen cabinet site.

There were slight differences between the four treatments as measured by monoclonal antigen tests (vacuum samples). There *was* a decline in the amount of detectable antigen in most apartments: Group A (range: 60 to 98 percent; mean: 54 percent; median: 94 percent); Group B (range: 6 to 99 percent; mean: 40 percent; median: 98 percent); Group C (range: 69 to 99.9 percent; mean: 85 percent; median: 89 percent); and Group D (range: 20 to 97 percent; mean: 63 percent; median: 66.5 percent). In two apartments, detectable antigen levels *increased*: one in Group A (117 percent) and one in Group B (100 percent).

Discussion. Tenant attitudes toward German

(Continued on page 6)

(Making a Difference…Continued from page 5)

cockroach infestations varied widely from total intolerance to very complacent attitudes, e.g., living with cockroaches is a fact of life. The presence of pesticide products (11 of 38 apartments initially surveyed), such as over-the-counter cockroach sprays and bait stations, indicated that some tenants were concerned about cockroaches and were taking things into their own hands with regard to cockroach control. The most extreme case was a tenant living in one of the most clean apartments who was spraying and applying boric acid by the pound around the baseboards, stove, refrigerator and the base of the kitchen cabinet. (It worked!) It is uncertain how these self-help efforts, e.g., spraying where baits were subsequently applied and unintentionally spraying over the baits in an effort to help us out, may have impacted our baiting program.

The study's results indicated that German cockroach population reduction could be accomplished with thorough inspection and bait application despite the level of sanitation in the apartment. However, it is important to note that reduction can be accomplished much more rapidly when the customer understands the health implications of cockroaches and their roles.

Groups A (baiting, cleaning and education) and B (baiting and education). The rapid reduction of cockroach populations in these apartments is a reflection of the initial information provided and the higher level of sanitation during the first 90 days of the study. The level of control may have been better maintained if our information exchange continued throughout the study. This would have resulted in less bait being used in these apartments.

Group C (baiting only). These apartments had acceptable levels of control but the lack of tenant concern about the cockroach infestations delayed the process.

Group D (self-help baiting and education). Self-help treatment in these apartments ranged from the bait being misapplied, i.e., spread all over the place like caulking and paste and to none being applied, despite our efforts to encourage tenants to use the bait provided. Thus, German cockroach control in most of the Group D apartments was much slower, indicating that tenant self-help programs require continuous reinforcement and even then can be expected to fall short.

The results of this study indicate that cleaning is the most significant factor in reducing the amount of Cockroach antigens in inner-city apartments. Antigen reduction was also noted in those units where baiting was the main management tool, however, in most cases, in the absence of cleaning, it appeared that the amount of cockroach antigens increased despite the reduction in the population. Unfortunately, cockroach control (and in some cases elimination) does little to reduce the amount of detectable antigen and does not appear to an effective stand-alone strategy in reducing cockroach antigens.

Housekeeping, i.e., sanitation, remained relatively constant throughout the study and was not a significant factor in the long-term management of cockroach populations using baits. Even in those units cleaned by our research group, the sanitation declined between each scheduled cleaning service, i.e., 30 days. Most occupants came to expect the service and did little on there own to maintain the state of cleanliness established at the outset of the study. Thus, it is unlikely that pest management companies can expect to get much cooperation in terms of cleaning from inner-city occupants despite strong encouragement.

The good news is that baits can be effectively used to manage, and in many cases, *eliminate* German cockroach populations, despite the level of sanitation. The keys to success are refreshment of the bait, numerous placements, regular and frequent inspections and precise baiting of active harborage sites. We feel that our control efforts would have been even better if all contiguous units were concurrently inspected and baited during the study. Baiting is used to control roaches in other parts of the building, but only on an occupant-request basis. Shortly after the conclusion of this study we were called by the management company to treat a recently vacated unit for cockroaches. This unit was heavily infested with German cockroaches and was directly below one of our participating units. The occupants had never requested service in the prior 12 months.

The most significant reductions in GRCD was noted in the kitchen cabinets. Several factors probably contributed to this: the kitchen cabinet was the greatest site of cockroach activity; cockroach harborage was abundant in all areas of the cabinet; the surfaces of the cabinets were relatively easy to clean in comparison to other surfaces which were covered with layers of grease and other food debris; and inner cabinet surfaces were not subject to as much translocation as the floor sites.

It is important to note that the clinical significance of

(Continued on page 7)

(Making a Difference…Continued from page 6)

these findings was not assessed in this study. To our knowledge, there were no documented cases of German cockroach allergy in anyone occupying the apartments in this study.

Summary of Project Impact. The findings of this study indicate that pest management companies can effectively manage cockroach populations and potentially improve the health of millions of children affected by cockroach allergens.

Baits were used exclusively in this study and resulted in a significant reduction in the amount of active ingredient applied in each apartment. Liquid insecticides can effectively accomplish the same level of control, however, depending on the product, there may be health concerns about volatile organic components and "inert" ingredients that may affect the health of already compromised individuals.

Aerosols and flushing agents, such as pyrethrin and pyrethrum, were not used in this study due to the risk of contaminating the baits and potential health concerns, e.g., respiratory irritation. Also, some researchers have expressed concern about agitating the cockroaches causing them to scatter and spread their antigens deeper into harborages and throughout the residential unit.

Baiting was successful in reducing or eliminating the cockroach populations despite the lack of significant changes in sanitation levels, however, cockroach elimination alone did *not* significantly reduce the level of cockroach antigen. While cleaning did not have a significant impact in reducing the cockroach population, it was the critical element in reducing the amount of cockroach antigen in the apartments.

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Life History and Habits of Fleas

PCT-Online
Michael Rust

Of the 2,237 flea species described as of 1979, less than a dozen have been widely reported as urban pests and only a few pose a serious medical or veterinary problem. About 94 percent of the described species feed on mammals, the remaining percent on birds. The vast majority of the species (approximately 74 percent) are associated with rodents (Marshall, 1981), highlighting the importance of a protected microhabitat such as a burrow or nest for development.

PHYSICAL CHARACTERISTICS. The body of the flea is well adapted to its ectoparasitic lifestyle. Dark colored adults are flattened from side to side with many bristles that point backwards, facilitating forward movement through fur, hair or fathers, and attachment to the host. The presence of genal combs also serves to help anchor the flea to the host, preventing its dislodgment.

Fleas are wingless creatures, with strongly developed legs, and hind legs that are especially adapted for jumping. They have sucking mouthparts designed to feed on the blood of mammals and birds. Their life cycle undergoes what is known as a "complete metamorphosis"; that is, they have an egg, larval, pupal and adult stage. The pupal stage is characterized by a cocoon constructed of silk and various bits of debris. The adult flea may remain in the cocoon for months before it emerges.

LIFE HISTORY AND HABITS. The following information deals primarily with the cat flea, unless otherwise stated, because it is the species most frequently encountered by PCOs.

Egg. The eggs are sufficiently large to be seen with the naked eye. They are about 1/50-of-an-inch long, smooth, translucent, glistening and oval. The eggs are not attached to the body of the host and they fall from the body or are shaken and scratched off. Byron (1987) reports that in a survey of a flea-infested home, the distribution of flea eggs is directly associated with the habits of the pet or host. Places where the pet frequents or rests have the greatest number. There are fewer eggs in areas adjacent to windows or commonly traveled areas.

Most eggs hatch in 1.5 to six days at 90 degrees Fahrenheit and 55 degrees Fahrenheit, respectively. Exposure to less than 50 percent relative humidity (RH) results in about 20 to 60 percent reduction in egg hatch. Eggs are killed when exposed to temperatures of 46 degrees Fahrenheit for 10 days or 37 degrees Fahrenheit for five days.

Larva. The emerging larva cracks the eggshell by means of a tooth on its head, which disappears with the first molt. The eyeless and legless larva is maggot-like, whitish, with a single row of bristles around each segment. The larva has a distinct head with a pair of short cylindrical antennae, three thoracic segments and 10 abdominal segments. The active larva has no legs and moves by means of the bristles which encircle each segment. The last terminal segment has a pair of anal struts which are used for vigorous movements.

(Continued on page 8)

(Fleas…Continued from page 7)

There are three larval instars lasting from six to 36 days after hatching. The larvae are very susceptible to desiccation and high relative humidities are important for development. Bruce (1948) states that relative humidities below 45 percent and greater than 95 percent resulted in complete mortality. At 50 percent RH larval development required 10 days, whereas at 90 percent RH larvae develop in five days (Silverman et al., 1981). Exposure of cat flea larvae in unprotected microhabitats such as the lawn or under trees where the RH may be less than 45 percent kills flea larvae (Silverman and Rust, 1983). Outdoor areas where flea larvae may develop are most likely to be in shaded and wind-protected areas with moist soils that are frequently visited by the host.

Flea larvae fail to develop at temperatures below 55 degrees Fahrenheit and at or above 95 degrees Fahrenheit (Silverman et al., 1981) At 80 to 90 degrees Fahrenheit, larvae mature in four to eight days whereas at 60 degrees Fahrenheit development requires about 26 to 36 days.

The small whitish larvae primarily feed on dried fecal blood produced by adult fleas feeding on the host (Bacot and Ridgewood, 1914). Stewart (1939) has this to say concerning the feeding habits of the larvae: "As a whole, hosts with nests are more commonly preferred to those without them. This is particularly true in the case of those species such as the European rat flea, *N. fasciatus,* whose larvae appear to require a meal of dried blood derived from the excreta of the adult flea for their development. Also in such cases, we observe that the adults spend a great deal more time in the nests than on the hosts, which is a provision of nature to supply the larvae with the necessary food."

Surveys of a flea-infested home for larval cast skins reveal that cat flea larvae do not move much, being found in areas where the pet rests and in protected microhabitats (Byron, 1987). The larvae readily sham death upon being disturbed.

Pupa. Just prior to the termination of the larval stage, the larva commences to weave a silken cocoon, which is spun from its own saliva. This cocoon incorporates small pieces of debris and organic sediment, camouflaging the cocoon in its natural surroundings.

The pupal stage lasts about seven to 10 days (Joseph, 1981) and is the most resistant immature stage to desiccation (Silverman et al., 1981). Similarly, Mellanby (1933) reports that the pupa of *X. cheopis* is resistant to desiccation whereas the prepupa fails to develop at 50 percent RH.

Adult. The adult flea may remain quiescent inside the cocoon for up to 20 weeks depending upon the temperature (Silverman and Rust, 1985). All fleas emerge within four weeks at 90 degrees Fahrenheit and within 20 weeks at 52 degrees Fahrenheit. At 95 degrees Fahrenheit only 10 percent of the emerged unfed adults will survive 10 days even at 100 percent RH, whereas at 60 degrees Fahrenheit, they will survive about 40 days (Silverman et al., 1981).

Waterson (1916) notes: "Persons entering a long-deserted house sometimes have cause to complain of hordes of fleas appearing, ‘suddenly’ after a short time. It is probable that in such cases, fleas resting in the cocoon, beneath floors, in cracks, etc., have come out in response to the vibrations caused by people moving in their proximity." Studies by Silverman and Rust (1985) show that direct pressure on the cocoon or combinations of increased temperature and direct pressure stimulate emergence. Exposure to carbon dioxide does not stimulate emergence.

Visual and heat cues are the primary stimuli that attract adult cat fleas to the host (Osbrink and Rust, 1985a). Moving dark objects on light backgrounds, or combinations of warmth and dark colors are attractive to fleas, adults being unable to orient in the dark.

The males usually emerge first and are less numerous than the females. Even though mated, the female flea will not lay eggs unless she has obtained a blood meal. The adults of many species of rodent or bird fleas visit their hosts for only a short time in order to obtain their blood meal. Cat fleas probably remain on a suitable host for their adult life span. Most species of fleas have definite host preferences, but do not necessarily feed exclusively on these hosts. This point is of prime importance from a health viewpoint, since the tendency of the flea to feed on several different species of animals enables it to carry diseases. In studies in which grooming was unrestricted, only 27 percent of the fleas were alive after 22 days (Hudson and Prince, 1958) and 47 percent of the fleas were alive after 15 days (Wade and Geogi, 1988). According to Bishopp (1921), in hot weather and with no animal to feed upon, adult fleas may live but from two to five days, whereas when they feed upon blood, they may live from a month to almost a year. "During the summer, probably the average longevity of the man flea

(Continued on page 9)

(Life History and Habits of Fleas)

without food is about two months, of the dog flea somewhat less, and of the sticktight flea still less." Cat fleas may be found on the host year round. In winter months the average number of fleas and percentages of cats infested are considerably less than in the summer (Lyon,1915 and Osbrink and Rust, 985b).

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Flea Control Using Boric Acid: How Safe Is It?

PCT-Online
Richard Kramer

During the past few years, manufacturers have made significant improvements to the products they offer for flea control. For instance, we now have pyrethroid products available as spot-ons; the insect growth regulator methoprene comes in a flea collar or can be sprayed directly onto animals and carpets; boric acid is available for broadcast application to carpets; and most recently, "the pill" containing the chitin synthesis inhibitor (CSI) lufenuron was introduced.

Despite all these new technologies, we still find ourselves in the flea control business and using conventional strategies. Regardless of these technological advances, we still have not found a single product that can deal with all aspects of a flea's biology in a single shot or in a timely fashion. There always seems to be a loose end. We have good tools for controlling the eggs and/or the larvae, or products that work well on adults; however the pupal stage remains an elusive problem. Treating outdoor areas poses another set of unique problems, which often require different products.

While many of the IGRs and CSIs are excellent tools and I endorse their use, they have two major drawbacks: They are slow to reduce the population, and the pupae and adults are unaffected. Thus most companies still rely on residual broadcast applications to carpets for the control of flea larvae and emerging adults. Because of this, the industry has been pressured to find less toxic products for flea control. This article provides one perspective on how to approach selecting least-toxic products.

Ask any pest control technician or customer, "What pesticide, in your opinion, is the safest?" The overwhelming response will most likely be boric acid. This response is based on a number of factors, not the least of which is the product's relatively low toxicity. In addition, many of the proponents of reduced-risk pest management have publicly promoted the perception that natural products such as boric acid are safer than their chemically synthesized counterparts. Dr. Nancy C. Hinkle of the University of California-Riverside recently reviewed some of the "natural" flea control products and their side effects (1995). You might be surprised to learn the variety of adverse effects associated with some of the "safer" products.

When we consider the issue of "least toxic," we must consider more than a product's derivation — i.e. natural or organic — and its acute toxicity. For instance, rotenone, nicotine sulfate, and strychnine are derived from plants and have very low toxicity. Many synthetic products can be viewed in a similar fashion. For instance, some of the organophosphates that have been used in the industry are extremely to moderately toxic, while the insect growth regulators have extremely low toxicity. Thus some of the synthetic products, such as IGRs and CSIs, are often many times less toxic than their natural counterparts.

One of the fundamental things you learn in this industry when working with pesticide products is the definition of Hazard (= Dose ´ Exposure). There are many factors that must be considered in determining what the hazard is, and in turn which products are least toxic. The following is a list of factors I use to compare products and to determine which are least toxic. It is important to consider several factors and not necessarily focus on a single issue.

• Acute Toxicity — usually measured in terms of LD_{50} or LC_{50} , LD_{95} or LC_{95}.

• Formulation — dust, emulsifiable concentrate, microencapsulate.

• Concentration — amount of active ingredient in applied solution; usually measured as a percentage.

• Application Rate — ounces or pounds per 100 square feet.

• Application Site — carpet, crack and crevice, spot, broadcast, outdoors.

• Exposure — skin, inhaled, ingested.

The tendency in determining what is least toxic usually centers around acute toxicity, which is measured in terms of lethal dose (LD), lethal concentration (LC) or lethal time (LT). This is the dose, concentration or time required to kill a percentage of the test population (usually rats), and is usually reported for the 50% or

(Continued of Page 10)

(Boric Acid…Continued from page 9)

95% levels. But this tells us nothing about the exposure. Exposure is related to where the product was applied, how much, and in what concentration. The formulation may also be a factor in how available the product is for exposure. In terms of dislodgeable residues, usually dusts > emulsifiable concentrates > microencapsulates.

Chronic toxicity is one area of concern that we cannot easily use in our decision- making process. This information is not easily quantified and is not well documented for most products. However, the other information on most products is sufficient to make informed decisions.

For the purpose of this discussion, I would like to compare the most widely used product in indoor flea control, chlorpyrifos, to what is considered by many to be one of the safest (perceived) products, boric acid. Furthermore, the *highest* labeled concentration and rate of application are used for the chlorpyrifos product, and the *lowest* labeled concentration and rate of application are used for boric acid. Using factors listed in the table below and the following formula, the toxicant load for each product, in terms of milligrams of active ingredient per 100 square feet, can be calculated.

In this case, there is 532 times more boric acid toxicant per 100 square feet than chlorpyrifos and a significant amount of dislodgeable residue in the form of dust. It is important to note that Hinkle et al. (1995) found that applying boric acid at a rate of 6.6 ounces per 1,000 square feet resulted in 90% suppression of flea larvae. Thus it becomes readily apparent that the rate of application for the boric acid product used in this comparison — 10 pounds per 1,000 square feet — far exceeds what is necessary to effect control. Hopefully, the manufacturers using these rates of application will reconsider the concentration and/or rate of application for their products.

The purpose of this exercise is not to extol the virtues of any product or to provide a recommendation for residual flea control. However, it serves to demonstrate that we cannot blindly accept the perception that a product is safe without examining the facts. Decisions on what products are least toxic should not be driven by marketing strategies, environmentalist hype or perception, but should be based on logical evaluation of the factors previously listed. After considering these factors, we can select products that pose the least risk to our customers and the environment.

DNA Shows Malaria Helped Topple Rome

The New York Times
20 February 2001
John Noble Wilford

An analysis of the bones of a child buried in a Roman cemetery more than 1,500 years ago has yielded what British and American researchers say is the earliest genetic evidence of malaria infection to be identified so far.

Traces of malaria had never before been identified definitively in such long-buried skeletons. The research encouraged some archaeologists to predict a wider and more productive alliance between biomolecular science and traditional excavation archaeology.

Archaeologists said that, in particular, the new findings provided strong support for the hypothesis that a widespread outbreak of an especially lethal form of malaria in the fifth century A.D. probably contributed to the decline of the Roman Empire. On the other hand, the epidemic may have saved Rome from a sacking at the hands of Attila the Hun, whose fear of the fevers may have caused him to turn back short of the city.

Until now, however, evidence linking the pestilence to malaria has mostly been from a few literary sources and indirect clues in a cemetery for infants uncovered at a villa near the town of Lugnano, 70 miles north of Rome. All the burials, some in mass graves, occurred over a brief period around the year 450. The presence of decapitated puppy skeletons, a raven's claw and other offerings of pagan ritual seemed to reflect the panic of an officially Christian people in the face of unsettling disease and death.

In the first successful application of new technology in finding traces of such ancient malaria infection, researchers at the University of Manchester Institute of Science and Technology in England were able to isolate minute samples of DNA from leg bones of a 3-year-old child. The DNA proved to be 98percent identical to that in people infected with *Plasmodium falciparum*, the most virulent of the four species of human malaria.

Reporting on the tests in the current issue of the journal Ancient Biomolecules, Dr. Robert Sallares, a research fellow at Manchester, and Susan Comz, a student, said that two independent extractions and analyses produced similar results. "It is reasonable to

(Continued on page 11)

(Malaria Topples Rome…Continued from page 10)

conclude," they said, "That an infection with *P. falciparum* malaria was indeed the cause of death."

In a telephone interview, Dr. Sallares explained, "If there wasn't a vigorous infection at the time of death, I don't think we would have been able to find anything."

Of perhaps surpassing importance, the scientists said in their report, "These results confirm the utility of this method for detecting malaria DNA in human skeletal remains."

Dr. David Soren, a classical archaeologist at the university of Arizona in Tucson praised the DNA results as "new and really exciting" because "the idea that this deadly type of malaria really existed in imperial Rome had never been documented."

An international team led by Dr. Soren excavated the children's cemetery in the early 1990's and discovered more than 50 small skeletons. Most, found in earthen jars, were the remains of stillbirths and early infant deaths. The falciparum parasite is known to cause miscarriage and infant death. A few older skeletons had porous and pitted cranium surfaces, which can result from an infectious disease like malaria.

This and considerable circumstantial evidence led Dr. Soren to the hypothesis that malaria epidemics might have had grave consequences on Rome. Scientists at the university of Rome have found evidence showing that falciparum malaria came from Africa, underwent mutations in Sardinia and was introduced in the marshy, mosquito infested Tiber River basin by the fifth century.

Dr. Frank Romer, a Roman historian at Arizona, noted accounts of pestilence spreading through the countryside at this time and causing "sweats and chills," symptoms typical of malaria. It was in 452, a year or two after the infant burials, that Attila, marching toward Rome, suddenly decided against entering the city.

If the DNA tests have indeed linked the infant deaths to malaria and not some other causes, Dr. Soren said he hoped other archaeologists would take notice and begin to incorporate biomolecular research in their investigations.

"I think in 10 to 15 years, this will come to be standard practice in archaeology," he said. "We need not just excavate bones and throw them into a closet. We need to take these bones and make samples for DNA Testing.

But Dr. Sallares sounded a note of caution. His laboratory in Manchester has wide experience using DNA analysis in examining human genetic mutations, crop genetics for studies in the history of agriculture and the family relationships of people buried in ancient Anglo-Saxon cemeteries. He is the author of "Malaria and Rome," being published this year by Oxford University Press.

In his journal article, Dr. Sallares said that "to unlock the full potential of biomolecular archaeology in relation to malaria and tackle all the fascinating problems" would require "much more work" developing reliable methods of analysis.

The analysis for the children's cemetery, for example, Dr. Sallares said in the interview. The fragile bones of the youngest children were too degraded to produce useful samples; only those of a 3-year-old child, the oldest in the cemetery, yielded results. Pitting in its skull just above the eye sockets suggested that the child might have suffered malaria.

Pieces of a leg bone, considered more likely sites of bone marrow containing DNA traces, were ground to a powder. Then silica was added because it binds to DNA, if any remains. To isolate the DNA, researchers used a laboratory technique known as polymerase chain reaction, or PCR. Its ability to make something of almost nothing is one of the miracle advances of current genetic research.

By amplifying any residual DNA in a sample, making a million or more copies of a single molecule, PCR enabled the scientists to detect and decode the imprint or malaria on the human genes.

All this took several months, Dr. Sallares said, and it has yet to be determined how widely the PCR technique can be applied to the detection of other diseases or how far back in antiquity such investigations can yield results.

But when the scientists got a positive reading that the child in the Lugnano cemetery had an active malarial infection at the time of death, they repeated the tests to be sure this was no fluke. In December, Dr. Sallares was satisfied with the results of this unusual post-mortem examination, and he shared the good news with Dr. Soren.

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Holding Off the West Nile Virus

IPM Solutions-Gempler's

The West Nile virus, which has been blamed for the deaths of at least nine people in the New York City area over the past two years, could strike again without warning over the summer months.

But a task force in Florida has been developing various initiatives – some of them involving Integrated Pest Management (IPM) – in case the disease comes into the Southeast.

Jack Petersen is an Extension medical entomologist with Florida A&M University and a member of Florida's West Nile virus task force, which also includes representatives from Florida's Department of Health and Department of Agriculture and Consumer Services. Petersen says while the West Nile virus has been discovered in 11 states and the District of Columbia, it has not been found in Florida, Georgia or South Carolina. However, he says the arrival of the disease into the Southeast should not be ruled out.

"We are making an attempt to inform people that there is a new mosquito-transmitted disease that should be taken seriously," he says. "What we are trying to do is understand the transmission of West Nile virus and be prepared for its eventual appearance in our state. Because it has been found in migratory birds, we fully expect that the virus will continue to spread, and it is likely to appear in states where it has not been reported in previous years."

Symptoms of the West Nile virus include fever, headaches and body aches that may develop into inflammation of the brain (encephalitis) or inflammation of the membranes surrounding the brain and spinal cord (meningitis).

Yet, Petersen says 80 percent of the people bitten by mosquitoes infected with the virus develop no symptoms, and all of those who died from it in the New York City area were over the age of 65.

He says researchers have been testing migratory birds, which were found carrying the disease in New York two years ago, as well as horses.

"More horses (than people) have become infected with the West Nile virus," Petersen says. "Florida is a very important horse rearing state, and the horse industry is concerned."

Last October, blood samples were taken from 75 horses that were being monitored for the disease. "No virus was found so the horses are clean," Petersen says. "Periodically, the horses will be examined to determine if they have antibodies related to the West Nile virus. I don't think any other state is doing that."

Petersen says researchers have also captured wild mosquitoes in Florida and have tested them for the disease. "At this point, no West Nile virus has been discovered in any Florida mosquito," he says.

Using IPM

Petersen says IPM is a key ingredient in stopping the development of mosquitoes before they can spread the West Nile virus.

"You can reduce the mosquito population by eliminating them at their breeding sites when they are in the larval stage," he says. "If you wait until they are adult mosquitoes with wings, then you've got a moving target."

He says it's important to know where West Nile virus-carrying mosquitoes come from and where the larvae are. For example, *Culex pipiens*, the mosquito breed that carried the West Nile virus in New York City, develops in organically rich water and sewers. He says *Culex pipiens* can be controlled by applying biopesticides approved by the Environmental Protection Agency (EPA) and by modifying sewers, ditches and other waterways so the water flows freely.

Petersen says he agrees with the recent decision by the New York State Department of Health to refrain from spraying pesticides before using IPM techniques.

"They will do other things first, and they will only spray from helicopters when there are human cases," he says. "If birds are involved, they are going to go to the larval breeding sites; they're going to do engineering modifications and use biopesticides to attack the problem. They are not going to load up the helicopter with an organophosphate and spray it from the air."

Petersen believes past pesticide-use decisions were too hasty, and holding back on applications now might have been in response to objections by the public and New York environmental groups.

"I think they were caught off guard. They brought in

(Continued on page 13)

(West Nile…Continued from page 12)

their heavy guns too soon," he says.

Combating the virus
Petersen says people can help reduce the dangers of the West Nile virus by following certain steps. These include cleaning up backyards, using repellents such as DEET, and wearing appropriate clothing such as long pants and long-sleeved shirts. He also says people should stay inside during dawn and dusk hours (from 6-6:30 in the morning and evening) when mosquitoes have the greatest presence.

The Centers for Disease Control (CDC) has already alerted other states of the possible spread of the West Nile virus, and Petersen says there is major concern that infected birds could fly from the Northeast into Florida and surrounding states.

"The Southeast is most likely to become infected because of the migratory bird flight path that goes from New Jersey right down the coast to Florida and into the Caribbean," he says. "So, we are particularly concerned."

Twenty states along the East Coast from the Northeast to Florida have received funding through the CDC to prepare for the possible arrival of the virus. Petersen says Florida has taken a leadership role because of its historic involvement in other mosquito-related illnesses such as St. Louis encephalitis and Eastern Equine encephalitis, and that the state will definitely have a plan in place if the West Nile virus should strike.

"Unlike New York, we will not be caught off guard," he says. "Florida will be ready."

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Controlling Mosquitoes Without Pesticides

Gempler's
June 2001

While many people consider summer the best time of the year, it comes with a major nuisance: mosquitoes. Those tiny flying creatures can be an annoyance for commercial growers as well as for the average family trying to enjoy a picnic in the park.

Mosquitoes have also been responsible for business losses at outdoor recreational facilities, golf courses and various resort areas. But most importantly, mosquitoes can jeopardize public health by transmitting encephalitis, a condition that causes inflammation of the brain and destruction of the central nervous system, and the West Nile virus, which has killed at least nine people in the New York City area in the past two years.

Pesticides are still widely used to hold down the onslaught of mosquitoes, but many communities are starting to use Integrated Pest Management (IPM) to minimize their development before they get to be a problem. In some cases, the use of IPM to control mosquitoes has led to significant reductions in chemical spraying.

Cy Lesser, mosquito control chief at the Maryland Department of Agriculture, says most mosquito control districts in the United States believe in the IPM approach to controlling the pests.

"A surveillance program is tailored to the local area where the program is operated," he says. "It involves knowing what species of mosquitoes are present, the habits of those mosquitoes, and if they feed on people or domestic animals or spread disease."

Lesser says determining what measures are needed to control mosquitoes is similar to pest management programs used by commercial growers.

"It's just like in crops where you establish a minimum threshold. If you are below that threshold, no control is warranted, and if you are above it, you take various steps," he says. "The same thing is done for mosquitoes by using light traps and other means to assess adult populations and having inspectors go out to measure wetland populations and the relative abundance of mosquito larvae, then targeting the most efficient and effective way of combating or reducing those populations to acceptable levels."

Mosquito control through education
Lesser says communicating with the average homeowner is one of the best ways to make a mosquito control program successful.

"It's not always the large swamp or roadside ditch where mosquitoes are breeding and affecting neighborhoods," he says. "Often, people are providing habitat for mosquitoes in their own backyards and they don't know it. We are educating people about removing stagnant water in small containers such as wheelbarrows, clogged rain gutters, cans, buckets, playground equipment. We try to urge people to remove water on their own without any involvement of public agencies or the use of pesticides."

Lesser says public education has been especially

(Continued on page 14)

(Controlling mosquitoes…Continued form page 13)

vital in combating the Asian Tiger mosquito, which has been a serious pest problem in urban areas since it first entered the Eastern United States in the mid-1980s. "Before the introduction of this mosquito, there were very minimal mosquito problems in urban areas," he says. "Now, this mosquito has very much become an urban pest, because it relies solely on containers provided in the community setting for its larval habitat. People are being educated on getting rid of trash and old tires, and turning over containers such as flower pots, bottle caps, discarded plastic wrappers, kiddy pools, pet dishes and birdbaths. Anything that can hold stagnant water, even very little water, for more than one week is a potential mosquito breeding site."

Lesser says that in Maryland, the Cooperative Extension Service has started a new program this year that teaches homeowners how to minimize the spread of mosquitoes when they are planting a garden or improving their property with new landscapes.

"Inadvertently, people can create mosquito problems in gardens and ornamental landscaping by improper use of plastic tarp, improper grading of land so water accumulates, or allowing empty flower pots to fill up with rainwater," he says.

County Extension agents are also doing their part to advise farmers and horticulturists on how they can lower mosquito problems in their communities. Lesser says that many growers who use irrigation in the Western United States may be unaware they are contributing to the mosquito population.

"In many areas of California and throughout the West, it is irrigation of agricultural lands that leads to the highest number of mosquitoes," he says. "Just by knowing they can apply enough water so the water irrigates the crop but doesn't stand for more than a week at a time, they can eliminate the production of mosquitoes."

Lesser adds that county Extension agents are educating rice farmers in Louisiana, Texas and Arkansas on how to prevent shallow flooding in their fields for long periods of time to reduce the development of mosquitoes.

Other control methods

Mosquito control districts have used other methods to minimize the growth of mosquitoes, and many have worked without dependence on pesticides. Lesser says one method, known as "source reduction," involves the modification of waterways so they don't become areas where mosquitoes can develop.

"They (mosquito control districts) make sure drainage ditches in communities are free flowing and not clogged up," he says. "Storm water ponds are properly designed and maintained so they don't become mosquito-breeding habitats. Local zoning and planning people are also informed by mosquito control people how to keep storm water ditches and ponds up to standard, so they don't become a problem. And all of that is done without the use of pesticides."

Another method involves the installation of predatory fish that feed on larvae before they develop into adult mosquitoes.

"These fish are self-sustaining, biological control agents that will sustain themselves for years and indefinitely control mosquito larvae that way," says Lesser.

He says a similar method known as "open marsh management" has been very successful at holding down the population of the New Jersey mosquito, which had been breeding in various marshes along the East Coast.

"It combines the physical alteration of the marsh with the biological control of the fish and results in a 95 percent reduction of the mosquito population without the use of pesticides," he says. "New Jersey, Delaware and parts of the East Coast down to Florida have used open marsh management successfully to get rid of mosquito breeding sites. It's very long term control and it's very environmentally favorable because it improves habitat for fish and wildlife at the same time it is reducing habitat for mosquito larvae."

Lesser adds that the use of biopesticides registered through the Environmental Protection Agency (EPA) is another alternative that has been successful at controlling mosquitoes.

"They have relatively low toxicity and fairly narrow range of impact to non-targets," he says. "The spores of the bacteria are delivered in a liquid or granular form to the water where mosquitoes breed. The mosquitoes eat those spores and they die just as the agricultural pests die when they are subjected to bacterial applications."

Mosquito control districts have also found success with the use of methoprene, a growth regulator that

(Continued on page 15)

(Controlling mosquitoes…Continued from page 14)

that prevents mosquito larvae from maturing into adults, because it contains a high level of juvenile hormone. Lesser says that methoprene has very little environmental impact and is broken down quickly by ultraviolet light.

Chemicals sometimes needed

According to Lesser, conventional EPA-registered pesticides are still used occasionally to kill mosquito larvae in places such as wetlands and swamps, but he says those chemicals have little impact on fish and other aquatic life. However, when it comes to controlling adult mosquitoes that hatch from the larvae, pesticides are the only way to stop them. Lesser calls pesticide use the "least effective and least desirable method to control mosquitoes."

"One thing we've been looking for decades but still haven't found is an effective biological control aimed at adult mosquitoes," he says. "There has been evaluation of bats, swallows, spiders and various other predators of adult mosquitoes, but usually it's only a small part of the population they are able to reduce. There doesn't seem to be an effective way to reduce the population so adult mosquitoes are not a public health problem or pest problem."

Aside from that, Lesser says the number of chemicals that are available to control mosquitoes and the way they are used has been constantly changing due to stricter EPA regulations.

"When I first got into mosquito control in the early '70s, there were a dozen products used for adult mosquito control," he says. "Now, we are down to a handful of products. Certainly, there's been a lot of evolution of getting away from the products we used to use. A lot of the refinement is getting down to small doses that are applied in amounts of less than one ounce per acre." Meanwhile, Lesser says county Extension agents and other officials will continue their efforts to inform homeowners and commercial growers how they can do their part to lower the population of mosquitoes without depending on pesticides.

"Most mosquito control people are geared to be very proactive," he says. "They don't want to wait until the phone starts ringing and have people complain that there are a lot of mosquitoes around or wait for the occurrence of disease. Most districts want to go out and educate people and make them aware (of how to reduce mosquito populations)."

Making a New Mosquito

Will messing with Mother Nature save millions from malaria, yellow fever, encephalitis and West Nile fever--or make matters worse?

Michael D'Antonio
Discover May 2001

In a cluttered lab annex at Michigan State University, two entomologists huddle in front of a 26-inch computer monitor aglow with a jumble of fuzzy antennae, bent legs and multilensed eyes. Dressed in a white coat, his face lighted by the screen, Vladimir Kokoza works his keyboard and mouse to bring an insect's body parts into focus. Soon an image emerges of an Aedes aegypti mosquito enlarged to horror film dimensions. Leaning over Kokoza's shoulder, Alexander Raikhel points to the insect's eyes, noticeably a deep red thanks to genetic manipulation. Raikhel's pale face softens into a paternal smile. "These little Aedes are one step toward making a series of custom-made mosquitoes," he says.

Bloodsucking mosquitoes are perhaps Earth's most persistent scourge, delivering malaria, dengue, yellow fever and a host of other diseases each year to more than half a billion people and killing between 2 million and 3 million. In the United States alone, billions of gallons of pesticides are sprayed each year in an effort to eradicate the tiny beasts. But at Raikhel's East Lansing lab, mosquitoes are treated with lavish care. They occupy safe, temperature-controlled rooms. They are protected from predators and disease. And Raikhel's associate, Kokoza, on occasion offers up his own flesh for feedings, coaxing even the feeble ones to partake of his blood.

Nothing is too good for these laboratory mosquitoes, because Raikhel and Kokoza believe they can be transformed from disease vectors into disease fighters. Through various forms of genetic manipulation, Raikhel and his competitors at a handful of other labs are trying to deprive mosquitoes of their ability to spread parasitic infections. Raikhel's strategy is to boost the immune response of mosquitoes so that they kill pathogens hey would normally harbor and pass on to humans. Red eyes serve as markers in his laboratory brood of modified *Aedes* mosquitoes for a designed gene that triggers heightened production of the immune protein defensin, which recognizes many microbes and destroys them.

(Continued on page 16)

(New Mosquitoes…Continued from page 15)

Within a few years, descendants or cousins of these transgenic mosquitoes could be among the first man-made animals purposely set loose in a natural environment. Raikhel's ultimate goal is to have mosquitoes armed with extra defensin, or other immune factors like it, interbreed with and displace wild mosquito populations, in the process stopping the spread of disease to humans. "We could make mosquitoes that are genetically dominant in the wild and yet incapable of transmitting disease, " says Raikhel. "That's our hope anyway."

Of course, genetic manipulation is not without risk. At the very least, transgenic mosquitoes could turn out to be an expensive boondoggle. At worst, they may be only temporarily effective and could lead to epidemics as wild mosquitoes rebound and begin biting people who have lost protective immunities over time. The closer Raikhel and other mosquito makers get to success, the more uneasy skeptics become. "Transgenic mosquitoes will mutate," warns entomologist Andrew Spielman of the Harvard School of Public Health. "Just how, we don't know,"

Entomologists and cell biologists began toying with the idea of creating a designer mosquito nearly two decades ago. "Most of the tools we have to deal with mosquitoes--medicines and insecticides--go back to World War II or just after it," notes entomologist Frank H. Collins of the Center for Tropical Disease Research and Training at Notre Dame University. And they were proving increasingly ineffective. For example, *Plasmodium falciparum*, the most dangerous of the protozoans that cause the deadliest mosquito-borne disease-malaria-had grown resistant to many drugs.

An even more vexing problem was the tenacity of mosquitoes, which predate humans on Earth and possess an uncanny ability to adapt to almost any environment. One African dwelling species lays its often germ-infected eggs in the sand, where they lie dormant for decades until a freak rain. Then they hatch and take to the air, ready to infect humans. Other species living closer to people no longer seek out ponds and swamps which to breed; instead they lay their eggs opportunistically. *Aedes aegyptii*, for example, breeds in tires, bottles and tin cans. As early as the 1950s, scientists noted that many mosquitoes could withstand the most potent insecticide, DDT.

Mosquitoes are not created equal, however. Only 100 or so of the 2500 mosquito species are known to transfer pathogenic germs to people. Most don't feed On humans at all, preferring the blood of animals. Of those that do feed on human blood, many kill off the pathogens they acquire before they can pass them on in another bite. By the mod-1980s Raikhel and others began searching for clues about how these "incompetent" mosquitoes stop the transmission of disease, as well as how that trait might be transferred and made genetically dominant in more dangerous species. First, researchers set out to try the simplest manipulation--inserting a gene for eye color--to prove that a mosquito could be altered. They chose *Aedes aegyptii*, a carrier of yellow fever and dengue viruses, because it is easy to breed. Success seemed guaranteed based on experience with another popular laboratory insect, *Drosophila*; labs had been creating new models of the common fruit fly for decades. Surprisingly, the mosquito makers ran into trouble. "For about five years, every time we went to meetings we did nothing but talk about our failures," says Raikhel.

At the University of California at Irvine, recalls geneticist Anthony James, "we tried maybe 80 or 90 experiments involving hundreds of thousands of mosquitoes and just couldn't get it to work right." The problem turned out to be the scientists' choice of a transposable element, or transposon. These small pieces of DNA can worm their way into a living organism's chromosomes, and genetic researchers use them to insert new genes in plants and animals. Mosquito engineers were working with a transposable element called P, which had been used for years in Drosophila. "It turns out that the fruit fly has several host factors--proteins--that facilitated [entry of] P," says James.

A major break came in the mid-1990s when molecular geneticist David O'Brochta of the University of Maryland Biotechnology Institute discovered another transposon in houseflies that he names Hermes after the Greek messenger god. Other researchers subsequently identified three more-mariner, Minos and piggyBac. In 1998, James hurdled the barrier: using material into the mosquito genome, he produced an Aedes aegypti with red eyes.

James's success galvanized work at other labs. Raikhel quickly focused on boosting the mosquito's manufacture of defensin. Like many animals, including humans, mosquitoes produce the protein to ward off invasion by bacteria; defensin punches holes in bacterial cell walls, destroying them. But

(Continued on page 17)

(Making a New Mosquito…Continued from page 16)

more-evolved parasites, such as the protozoans that cause malaria, have over the eons developed what Raikhel calls "a well oiled system" that allows them to escape detection when ingested by a mosquito and flourish inside the insect without harming it. Eventually the parasites migrate to the salivary glands, where they wait patiently for the mosquito to alight on human flesh and transfer them to a new host, where they can wreak real havoc.

Raikhel figured that if he could manipulate mosquitoes to produce defensin whenever they dined on blood, it would kill parasites before they could reach the salivary glands. First, he found a gene that is switched on by a blood meal. Then he combined it with the gene that directs defensin manufacture. Next, he needed to insert this new chimeric gene into *Aedes aegypti*. Raikhel and his team quickly set up an assembly line to accomplish the dauntingly delicate task. Poppy-seed-sized eggs laid by the mosquitoes in tiny Plexiglas cages were carefully harvested and placed under microscopes. Steady-handed technicians pierced each shell with an ultrafine needle crafted on-site and injected the new DNA--the transposon Hermes carrying the chimeric gene and a marker eye-color gene. Then the eggs were incubated in shallow dishes filled with warm water. Larvae emerged, developed into pupae, and hatched as adult mosquitoes. These mosquitoes then mated with each other. When their offspring hatched, lab assistants scanned trays of the new insects under a microscope, searching for the telltale red eyes that would indicate a transgenic mosquito had been born.

"One of the guys here was a very fast worker, " says Kokoza. "He just took the trays with hundreds of hatched mosquitoes, and if e didn't see red, he froze them." But hidden among the glassy wings and soft bodies one day was a pair of red eyes. They weren't discovered until the creature was dead. "He said: 'No problem. We'll make another one,'" says Kokoza with a heavy sigh. "It took us about six months."

Once the red-eyed mosquitoes began to turn up in greater numbers, Raikhel confirmed that he had made the first functional transgenic mosquito--an insect that not only looked different but acted in a novel way, producing defensin at every blood feeding and transferring that trait to generation after generation. "We had a good idea, but it was built on work done at many labs," says Raikhel. "The important thing is that after 15 years, making transgenic mosquitoes is becoming routine. Now we can address more questions."

The primary challenge facing scientists bent on making a useful mosquito is to engineer one incapable of transmitting malaria. For that they will have to turn their attention away from *Aedes aegypti*, the laboratory favorite, to *Anopheles gambia*, the chief carrier of malaria-causing *Plasmodia*, and therefore the most dangerous mosquito on Earth. Although *Anopheles* is more difficult to breed and maintain, its genome is well understood. And Raikhel, for one, is confident the gene that stimulates defensin production in Aedes can be inserted in Anopheles.

Meanwhile, Raikhel's competitors are investigating other possibilities. Anthony James has successfully inserted a gene in Aedes that normally stimulates production of malarial antibodies in mice and eventually hopes to try his luck with *Anopheles*. Marcelo Jacobs-Lorena at Case Western reserve School of Medicine is exploring the coaxing of lab mosquitoes to make peptides that would coat their salivary glands and block parasites from entering. Frank Collins and others are focused on creating a mutant Anopheles that will kill the parasite by "melanizing" it with a hard shell of pigment. The development of a transgenic *Anopheles* with the ability to kill malaria and dominate the mosquito gene pool appears to be just a matter of time.

As Raikhel and others move closer to their goal, they are raising the stakes in a growing argument over whether it is practicable or wise to create such genetically engineered creatures and set them loose in the environment. To begin with, transgenic mosquitoes would need to be created for each of the estimated 100 species that carry illnesses that affect humans. To further complicate matters, strains of these mosquitoes vary from place to place. And then there's the problem of multiple vectors. In certain parts of the world, some diseases have primary, secondary and even tertiary carriers. "In Mopti, a village in Mali, there are seven different mosquitoes that transmit malaria," says Andrew Spielman. Each of those seven species is genetically different, and to fight malaria, the genetic engineers may have to create seven different transgenic mosquitoes. Even if the mosquito makers are successful, Spielman adds, experience with other animals shows that transposons can lose their effectiveness.

If these problems aren't enough, and the mosquito engineers somehow produce the perfect insect for every occasion, where is the village or town that wants a million or so biting pests released? Five decades in the field have led Spielman to conclude that it would be "almost certainly impractical" to

(Continued on page 18)

(Making a New Mosquito…Continued from page 17)

release mosquitoes in any place where people live. In India in the 1970s, Spielman recalls, the world Health Organization sent teams to small villages to release thousands of male mosquitoes that had been sterilized by radiation. Theoretically the sterile males would mate with females and, since mosquitoes generally copulate just once in a lifetime, there would be no offspring. Soon after the project began, however, rumor spread that it was a foreign government's plot to sterilize people via mosquito bites. The scientists were driven away by angry residents, and the project was canceled. In today's world, where genetically modified vegetables spark protest, any effort to deliver truckloads of transgenic insects into people's backyards "ain't gonna work," Spielman says.

The highly respected Spielman's words of caution are taken seriously. But the cell biologists who work on transgenics wonder if they aren't encountering a generation gap. "The older guys have seen a lot of ideas fail and are skeptical," notes James. "I understand that. But it doesn't mean we don't try something new." In Collins's view, malaria is so bad in certain parts of the world that radical solutions will be welcome in many places. "Any idea, whether it's transgenic mosquitoes or something else, will have to be explained very openly and completely. But if you go to a village where a quarter of the kids die from malaria and a lot of the adults are sick all the time, I don't think you'll get much argument."

Raikhel agrees. The quest for a safe man-made mosquito, he insists, offers the best strategy for defeating one of the world's oldest and deadliest pests. "Our enemies are constantly finding new ways to defend themselves," he says. "So must we."

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Brush Up On Your Spider Inspection Techniques

PCT-Online
Amanda Paskiet

Spiders, while beneficial creatures that keep the number of many structural pests in check, can also become problematic when they cause harm to humans and animals. Stoy Hedges, manager of technical services for Terminix International in Memphis, Tenn, gave advice on how to inspect areas for spiders in and around buildings at the 65th Purdue Conference in January.

Because some species cause serious injuries if they bite humans or animals, "Spiders, especially the brown recluse, black widow and aggressive house spider, require immediate control efforts when even one is found in the home or building," Hedges said.

And although some inspection strategies will depend on the species of spider involved, there are some important steps that PCOs should follow when inspecting any structure for spiders.

I.D. IT

First, the PCO needs to identify the pest or pests involved, which Hedges admitted can often be the most difficult task in servicing spider infestations. He suggested that PCOs tell their customers to capture a specimen, which is vital if the spider in question is a brown recluse. "Most of the time, homeowners are very concerned that this spider is present and it needs to be confirmed that they are actually present before a PCO goes through all the steps to eliminate them," he said.

If the customer is unable to capture a specimen, Hedges advised that PCOs leave monitoring traps out for a night or two since many spiders are primarily active at night.

Web Building Spiders

Once the spider has been identified, the PCO can find where it lives and identify the conditions present that may be supporting the infestation. Web-building spiders often infest undisturbed areas in buildings such as garages, crawlspaces and basements. "These areas are rarely cleaned and unoccupied by much else besides insects, which provide a food source for the spiders," Hedges said. Spiders such as the black widow often build webs among piles of items and boxes stored in these areas and Hedges advised PCOs to wear gloves when inspection these areas.

Outside of the building, Hedges said it is important to inspect corners of windows and doorways and under building eaves. Other checkpoints include behind gutters, under deck railings, fences and light fixtures. "Any site where right angles are present serve as a good place for spiders to spin a web," Hedges said. "Plus, other insects are attracted to light fixtures, making a convenient food source for the spider."

Hunting Spiders

Hunting spiders tend to be more difficult to find because they spend most of their time in a web like their web-building counterparts. Although hunting spiders, such as the brown recluse male and jumping spiders, spin silken webs to rest, these retreats are often hard to locate, said Hedges.

(Continued on page 19)

(Spiders…Continued from page 18)

A flashlight can be an effective tool to find hunting spiders hiding in dark cracks and voids during the day. However, Hedges said some species have specific places they tend to occupy. For example, jumping spiders can usually be found around windowsills and doorways, and wolf spiders tend to be found along baseboards and inside boxes and closets. Outdoors, wolf spiders like to rest under stones, firewood piles and leaf litter. "And brown recluse spiders can be found anywhere in a building, they have no significant or favorite resting spots," Hedges said.

Once an inspection has been done, a PCO can evaluate what type of control method should be applied, Hedges said. Be sure to check out next Wednesday's feature to find out effective spider control techniques from Stoy Hedges.

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Got Recluses?

PCT Online
Rick Vetter and Stoy Hedges

Have you (or your customers) misidentified brown recluse spiders in the past? You may be surprised at the answer.

There are thousands of species of spiders in the United States, however, the average American is only familiar with two: the black widow and the brown recluse. The infamy surrounding these spiders is widespread due to tales, hyperbolic or otherwise, of their poisonous bites which have potential for severe debilitation and, in very rare cases, death. The black widow is somewhat less problematic from a pest control viewpoint because its characteristic coloration of shiny black body with ventral red hourglass makes it readily recognizable by the untrained person.

However, despite this, other spiders (female false black widows and immature bold jumping spiders, *Phidippus audax*) are sometimes confused with black widows. In contrast, the brown recluse is not as easily discernible by physical appearance and many different arachnids (some not even spiders) are misidentified as recluses by the general public, the medical community and PCOs. Because of misidentifications, hyperbolic media stories and medical misdiagnoses, the American public believes that the spider can be found throughout the United States.

In truth, the brown recluse is restricted almost solely to its native distribution. Although recluse literature always forebodingly states that they can be transported out of their range, brown recluses are extremely scarce and rarely — if ever — have they been successful at establishing a breeding population elsewhere. Despite all the hoopla that surrounds the discovery of a single brown recluse in the eastern seaboard, northern Midwest or Western states, typically this one spider is an itinerant that has been intercepted and does not represent a massive population outside its range.

RECLUSE SPIDERS. The brown recluse is the common name for one species of spider, *Loxosceles reclusa*. The genus name means "slanted legs" (probably named for the way it rests) and is pronounced similar to "isosceles," like in the triangle from that horrid math class years ago. It lives from Nebraska south through Texas and east to the southernmost edge of Ohio and south to Georgia. There are 10 additional *Loxosceles* species in the U.S. with 5 having somewhat extensive distributions and the other 5 being known from only a few localities. Two non-native species are present in the U.S. as well.

The south American violin spider, *Loxosceles laeta* (LEE-ta), has populations in basements and steam tunnels in a small pocket of urban Los Angeles, Calif., and possibly still lives in the basement of the Harvard University museum in Massachusetts as was reported in the past. A Mediterranean recluse, *Loxosceles rufescens*, seems to vagabond its way around the world and shows up in various cities around the United States, again often as single itinerants. All recluses are considered to have venom capable of causing wounds in humans and should be regarded with care.

ENDEMIC AREAS. One thing is true for recluse spiders of any species: when they find a habitat conducive to their survival, they are almost communal and you can easily collect many specimens. Regarding the brown recluse, it is not uncommon to find several spiders a week in a typical urban home within its range, where an occasional house supports more than 100 recluses at the same time. In a study done in Chile, 29 percent of the homes contained the south American violin spider with the five greatest infestations averaging 163 spiders (range 106 to 222 spiders).

Although these high infestation rates would probably give anyone the creeps, rarely do people suffer spider bites from these dens. The brown recluse is "synanthropic" which means that it increases in numbers when associated with humans. It is a common house spider in its range, yet the human

(Continued on page 20)

(Brown recluse…Continued from page 19)

population of the Midwest is living with millions of these spiders and many households never experience a bite. Although there are many similarities among the various *Loxosceles* species, there are also differences. The brown recluse is an urban pest while other native American species seem to be less so. The latter are typically found in the arid Southwest, only infest homes that are surrounded by natural vegetation and are not often found in urban homes.

NON-ENDEMNIC AREAS. Outside the native range in the United States, recluse spiders are extremely rare. Although the spiders do occasionally get transported around, populations of transplanted species are virtually non-existent. When it does happen, often the infestation is limited to one building (or several if interconnected by underground conduits). Unfortunately, this knowledge appears to be only well known to those few people who work with spiders as a significant part of their employment (arachnologists, vector control personnel and some, but not all, PCOs). The rest of the U.S. human population is thoroughly convinced that brown recluses are everywhere, running around causing midnight mischief, inflicting wounds and then evaporating into the night, never to be seen again.

This perpetual myth is kept alive by several aspects. First, speculative news stories are published, based on the *possibility* not *probability* of a recluse spider being found in a local area. Second, medical misdiagnoses are made of a variety of conditions (bacterial, fungal, viral, cancer, bites from blood-feeding insects, Lyme disease, poison oak/ivy, chemical burn) that look very similar to the spectrum of wounds caused by actual recluse envenomation. Third, the public's erroneous word-of-mouth, fed by arachnophobia, the media and the medical community, keeps the myth alive. Compounding this myth is that any brown creature with eight legs is all too often misidentified by the average homeowner as a brown recluse, which reinforces their erroneous opinions.

Even though both popular and medical literature continue to discuss how easily brown recluses are transported around the country, the lack of extension of their range is rather puzzling. However, one must remember that brown recluses evolved on this continent; hence, they are restricted to their range by a multitude of environmental conditions, predators, parasites and competition from creatures of similar ecological habits. Arthropods that disperse successfully across a continent are typically non-natives, flourishing in the absence of these regulatory pressures. Well-known examples include Africanized honey bees, red imported fire ants, Mediterranean fruit flies, German yellow jackets, many species of cockroaches and termites, just to name a few. Even among spiders, continental colonization is achieved more commonly by non-natives (e.g., woodlouse spider (*Dysdera crocata*), false black widow (*Steatoda grossa*), mouse spider (*Scotophaeus blackwalli*) cellar spider (*Pholcus phalangioides*), barn funnel spider (*Tegenaria domestica*)) than by natives.

IDENTIFYING RECLUSE SPIDERS. Virtually everything written about recluse spider identification gives a "Reader's Digest" version of the salient ways to identify a spider as a brown recluse. However, as with many things, the more you know, the more you realize that it isn't all that simple. It is often mentioned that you can tell a brown recluse by the violin pattern on its head region (i.e., cephalothorax). Although this is straightforward when you see a recluse, there are many other harmless spiders that have darkened coloration in the same area and they are creatively mistaken for recluses. These spiders include many cellar spiders (family *Pholcidae*) and pirate spiders (family *Mimetidae*) and the tiny *Oecobius* spiders.

In addition, immature and newly molted brown recluses may not have a well-defined violin. Adding more confusion is that the violin pattern of many western *Loxosceles* species is often indistinct or missing, where the pattern is often formed by hairs and not underlying pigmentation. Therefore, it is possible for a person in the Southwestern United States to identify a harmless spider as a recluse and a recluse as a harmless spider.

A more precise method requires a hand lens or magnifying glass to count the eyes, although once you see the eyes magnified, it should no longer be a problem to see the eye pattern without optic aids. Most spiders have eight eyes in two rows of four whereas recluse spiders have six eyes arranged in one row of couplets or pairs. There is one pair near the front of its cephalothorax and a pair on either side. If you draw a line through the eyes, it would make a U-shape with the open end toward the back. Rarely does an identification guide continue to tell you that there are additional harmless spiders (spitting spiders, family *Scytodidae*) that have the same eye pattern but usually are covered with black spots or lines. Spitting spiders are much more widespread in the U.S. than are recluses. Yet despite this relatively simple method to identify recluse spiders, most of the American public cannot identify a

(Continued on page 21)

(Brown Recluse…Continued from page 20)

recluse spiders, most of the American public cannot identify a recluse if it bit them. This is even truer when outside the endemic range of recluses where a multitude of non-recluse spiders are misidentified.

CONTROL. In controlling recluse spiders, the specimens running about or captured on sticky traps are typically males and spiderlings. The females are the true "recluses" preferring to remain in cracks and voids, rarely venturing out. For this reason, any treatment strategy relying primarily on surface (baseboard) and/or space (ULV) treatments is doomed from the start. The proper strategy to employ for this spider is painstaking treatment of cracks and voids with a residual dust insecticide from the attic to the basement or crawlspace (if present). These spiders commonly follow plumbing pipes and electrical wires to travel from area-to-area and room-to-room within a structure. Focusing treatments on voids where these "structural guidelines" run is a key tactic. Additionally, the cracks behind all baseboards and door/window frames require treatment with the selected dust product (Drione and DeltaDust both work well).

It is important to use a vacuum to remove spiders, egg sacs and webbing as these are discovered in and under furniture, within boxes, etc. Spot treatments along baseboards behind furniture are helpful for controlling wandering males and spiderlings. Also, one cannot place too many monitoring traps. Each spider captured is one that potentially cannot come into contact with a person. In addition, the outside is very important as exterior cracks need to be treated and potential harborages (e.g., thick ground cover, piles of items) need to be eliminated.

Finally, the customer needs to understand the steps they can enact to avoid potential bites. They also need to be advised that one service is not likely to solve the problem. In some, if not the majority, of cases, total elimination is impossible. Spider populations can be markedly reduced, but an occasional spider may still be seen. Monitoring traps help by capturing most spiders. Regular service visits for a number of months up to a year or longer are necessary, depending on the severity of the original infestation.

THE GOT RECLUSES? CHALLENGE. Besides the educational material presented here, this article also launches the "Got Recluses?" Challenge. The senior author is interested in embarking on a study to identify spiders in reference to recluse distribution in the U.S. and the ability/inability of the American public to properly discern potentially dangerous recluse spiders from the

- To determine if the current range of the brown recluse is similar with that historically known to arachnologists.
- To determine what spiders the American public identifies as brown recluses, whether they are correct or incorrect.
- To determine if there are any populations of recluses outside of their native range
- To determine whether these non-endemic populations are the brown recluse or possibly one of the non-native species instead. (Recently the senior author received many recluse specimens from New England, where the PCO had been calling them brown recluses for years. They were actually the Mediterranean recluse, which means that this becomes an issue of establishment of a non-native rather than range expansion of a native species.)

THE GOT HOBOS? CHALLENGE. Also, the hobo spider, *Tegenaria agrestis*, has been getting lots of publicity in the last two decades as a dangerous spider. However, if you think the public has trouble identifying brown recluses correctly, wait till you see what will be done with hobo spider misidentification. Although a hobo spider makes a funnel-web (a trampoline-like sheet that tapers back into a hole in which the spider sits), so do about 100 other species of similarly-colored spiders in the United States, including several harmless *Tegenaria* species. However, already the public (and PCOs, too!) have seen these webs and assumed they have hobo spiders. The only way one should verify a hobo spider, unless extremely experienced with them, is comparison of their genitalia to scientific illustrations.

The hobo spider is found in the Pacific Northwest east to Montana and south to Oregon and northern Utah. Currently there is no definitive publication describing the known range of hobo spiders. Because of all the misidentifications, they possibly are much more limited in their distribution than previously thought. Also, population dynamics change; hobo spiders used to be common in Seattle but have since been displaced by a harmless, larger cousin, *Tegenaria gigantea*, which is almost identical to a hobo spider. Therefore, this study would also like to determine the distribution of hobo spiders in the western U.S.

IN THE NEWS……

Hantavirus Found In San Diego County

Yahoo Daily News-19 June 01

Health officials have announced that they have found a form of hantavirus in deer mice near homes and industrial areas in San Diego and Orange counties.

The rodents were found in Anaheim Hills, Tustin, Newport Beach and the Cleveland National Forest in San Diego County.

Hantavirus can be transmitted to people.

Humans can become infected by exposure from mouse droppings, and the first signs of sickness (especially fever and muscle aches) appear one to five weeks later, followed by shortness of breath and coughing.

Once that phase begins, the disease progresses rapidly, necessitating hospitalization and often ventilation within 24 hours.

An outbreak of hantavirus in 1993 killed about three dozen people in the western region of the United States. Health officials say that you should be careful when removing rodent carcasses or droppings.

Spray them first with a solution of water and bleach before putting them in a double plastic bag. Hantavirus is not contagious from person to person.

Tips For Preventing Hantavirus

Indoors

- Keep a clean home, especially kitchen (wash dishes, clean counters and floor, keep food covered in rodent-proof containers).
- Keep a tight-fitting lid on garbage, discard uneaten pet food at the end of the day.
- Set and keep spring-loaded rodent traps. Set traps near baseboards because rodents tend to run along walls and in tight spaces rather than out in the open.
- Set Environmental Protection Agency-approved rodenticides with bait under plywood or plastic shelter along baseboards. These are sometimes known as "covered bait stations." Remember to follow product use instructions carefully, since rodenticides are poisonous to pets and people too.
- If bubonic plague is a problem in your area, spray flea killer or spread flea powder in the area before setting traps. This is important. If you control rodents but do not control fleas as well, you may increase the risk of infection with bubonic plague, since fleas will leave rodents once the rodents die and will seek out other food sources, including humans.
- Seal all entry holes 1/4 inch wide or wider with lath screen or lath metal, cement, wire screening or other patching materials, inside and out.

Outdoors

- Clear brush, grass and junk from around house foundations to eliminate a source of nesting materials.
- Use metal flashing (pictured, right) around the base of wooden, earthen or adobe homes to provide a strong metal barrier. Install so that the flashing reaches 12 inches above the ground and six inches down into the ground.
- Elevate hay, woodpiles and garbage cans to eliminate possible nesting sites. If possible, locate them 100 feet or more from your house.
- Trap rodents outside, too. Poisons or rodenticides may be used as well, but be sure to keep them out of the reach of children or pets.
- Encourage the presence of natural predators, such as non-poisonous snakes, owls and hawks.
- Remember, getting rid of all rodents isn't feasible, but with ongoing effort you can keep the population very low.

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Cricket Glut Forces Snack Price Down

Excite News
Submitted by LT Tracy Negus, MSC, USNR-EPMU5

(In the news…Continued from page 22)

PHNOM PENH (Reuters) - The price of raw crickets, a popular snack among Cambodians, has plummeted in recent weeks as heavy rains have made it easier to catch the insects, a local newspaper reported on Tuesday.

Market vendors sell the crickets -- hunted throughout the country -- either raw or fried to Cambodians who eat them like popcorn or nuts are consumed in the West.

"Just in one morning, I can collect one and a half to two tons of crickets in Kompong Thom province alone," one cricket vendor told the Rasmei Kampuchea (Light of Cambodia) newspaper.

"The price of crickets has dropped to 1,000 riel ($0.26) per kg, compared with 2,500 to 3,500 riel before," he complained.

A cricket hunter told the newspaper that he hadn't seen such high numbers of the insects for at least a year.

"I could catch up to 100 kg per night on the night of the rains," he said.

Vendors in northern Kompong Thom said they were putting the crickets on ice and sending them to be sold in Phnom Penh markets, about 75 miles south, where the insect-eating population is larger.

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Orkin Man Meets His Match: 400-Pound Gator

WKMG-News/ 05 June 01

An Orkin Pest Control employee working at a New Smyrna Beach house Tuesday morning discovered more than the typical Florida insects -- he found a 10-foot long, 400-pound alligator.

The man found the alligator laying in the shade in the back yard of the house. It was in a 100 foot by 60 foot area that is enclosed with a 3-foot fence, according to WKMG News.

No one knows where the alligator came from as the closest body of water is the Indian River about two blocks away. Trappers believe that the alligator climbed the fence to get into the yard.

"With the drought that we're having now, (alligators) are having to move to find new habitat," Andy Signell of the Fish & Wildlife Commission said.

No one was home at the time the gator was found, and the homeowner said that she thought the alligator was a tree when she looked out her window before leaving the home.

Neighbors were trying to get as close to the animal as possible, and one person was videotaping the entire incident.

But Signell warned that you should stay as far from alligators as possible.

"It could have hurt you worse than you can imagine," he said.

"I've lived in this property since 1945 and never had an alligator as a visitor," a neighbor told WKMG News reporter Tarik Minor.

Because of the size of the alligator, trappers decided to kill it rather than attempt to capture it.

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Rare Spiders Found In England

Associated Press/25 June 01

LONDON — Underground work on telephone lines near Windsor Castle has
uncovered nests of rare and possibly dangerous spiders, according to an article from the *Associated Press*.

The rusty red and black spiders could be a previously unrecorded species or one believed extinct in England for thousands of years, said Graham Smith, an entomologist with Project-ARK, a conservation team specializing in endangered species.

"The species is certainly venomous and the jaws are strong enough to penetrate the human skin. It will take a few days to work out how dangerous they are," Smith said. "Who knows how long these spiders have been in the royal park because they live underground. There could be literally thousands and thousands of them. It would be no surprise if they are living underneath Windsor Castle itself."

The spiders, which have a leg-span of up to 3.5 inches, were discovered by British Telecom engineers as they laid underground cables at Windsor Great Park in Berkshire, near the official residence of Queen Elizabeth II and 30 miles west of London.

(Continued on page 24)

(In the news…Continued from page 23)

The engineers have since stopped work while entomologists examine the spiders in an attempt to specifically identify them.

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Study Shows Antibiotics Prevent Lyme Disease If Given Quickly

Associated Press/ 12 June 01

VALHALLA, N.Y. — Doctors have discovered that a quick dose of antibiotics can ward off Lyme disease after a tick bite, according to an article from the *Associated Press*.

Some doctors already give antibiotics to people who are bitten by deer ticks, however, many experts oppose this because there has been no clear evidence the treatment actually prevents the disease, even though antibiotics can clear up Lyme disease once it occurs.

Now there is proof the approach works. A study conducted in New York's Westchester County, where Lyme disease is common, found that just two pills of doxycycline are highly effective if given within three days of a bite. "Ours is the first study to show that Lyme disease can be prevented after a tick bite," said the study's chief author, Dr. Robert B. Nadelman of New York Medical College in Valhalla, N.Y.

About 15,000 cases of Lyme disease are reported annually in the United States, mostly in the Northeast from Maine to Maryland; the Midwest in Wisconsin and Minnesota; and the West in northern California and Oregon.

The study also shows that even in a Lyme-infested area, deer tick bites rarely result in infection. In fact, only nymphal stage bugs filled with blood posed a risk.

The latest study involved 482 people who had removed a deer tick from their bodies within the previous 72 hours and brought it with them to the doctor for identification. They were randomly given either a 200-milligram dose of doxycycline or dummy pills.

The antibiotic was 87 percent effective at preventing Lyme disease, even though the overall risk was low, just 3 percent among those getting the dummy pills. This means it would be necessary to treat about 40 people to prevent one case of Lyme disease.

Still, Nadelman said it may make sense to treat people if if they are bitten by a blood-filled nymphal stage deer tick in an area where Lyme disease is common.

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West Nile virus expected to spread across country

CNN.com/15 June 01

ATLANTA, Georgia (CNN) -- The mosquito-borne West Nile virus, which can cause encephalitis and result in death, is expected to eventually spread across the United States, federal health officials said Wednesday.

It's likely the virus will spread slowly, including a potential risk to humans, outside of where it currently is," Dr. David Fleming, Centers for Disease Control and Prevention (CDC), told CNN. "But the good new is that we don't have to guess about that."

But the spread has been rapid along the eastern seaboard and researchers led by Dr. Denis Nash of the New York City Health Department recommended physicians in that part of the country be on the alert.

Mosquitoes spread the virus to birds, animals and humans. Most infected people never experience any symptoms, although some experience flu-like symptoms such as fever, headache and body aches. Since 1999, West Nile virus has made 74 people severely ill and caused nine deaths. All of the victims were in New York and New Jersey.

"So far in this country, there have been a fairly small number of cases that have required hospitalization. Last year there were only 21 cases in the United States," said Fleming. "But studies that were done show that only one in 100 to one in 150 people who are infected actually go on to develop symptoms."

The virus, first identified in 1937 in the West Nile region of Uganda, was detected in the United States two years ago after birds and humans in the New York City area were bitten by infested mosquitoes.

Since 1999, the virus has been detected in 12 states and the District of Columbia -- from as far north as Vermont down to North Carolina. So far this year, it's been detected in dead crows in New York, Connecticut, Maryland and New Jersey.

"We've detected the virus in 12 dead crows and a mosquito pool in Middlesex County," Dennis McGowan of New Jersey Health Department told
(Continued on page 25)

(In the news…Continued from page 24)

CNN.

The CDC has advised all state health departments to be on alert for signs of the virus. In response, Georgia for one has formed a West Nile Task Force. Individual counties are trapping mosquitoes and analyzing them.

"We are looking for a particular breed of mosquito -- it's the Culex mosquito," said Bert Tyler, Dekalb County Board of Health. "They are the ones that carry the West Nile virus."

The virus -- believed to have originated in Africa and been brought to this country by zoo animals -- can cause encephalitis, a sometimes fatal inflammation of the brain.

When West Nile virus activity is detected in an area, residents are alerted to take precautionary steps to protect themselves. Health officials suggest citizens who find dead birds or animals contact the local Board of Health.

It's also recommended that residents limit breeding grounds for mosquitoes by eliminating standing water in areas such as gutters, old tires, wading pools, outside containers and pails.

People can also limit their risk of being bitten by any type of mosquito by wearing long sleeves and pants, especially at dawn and dusk when mosquitoes are more prevalent and by wearing a repellent containing the chemical DEET.

"People who are most at risk for developing severe symptoms include those individuals who are elderly or have problems with their immune system," said Fleming.

A study published in this week's New England Journal of Medicine found older age was associated with a higher risk of more severe neurological disease and both age and diabetes appeared to increase the risk of death.

West Nile virus infection should be considered in patients with encephalitis and viral meningitis during the summer months, especially in older patients and those with muscle weakness.

On The Web

PEST MANAGEMENT AND IDENTIFICATION-University of California-Davis Pest Management Guidelines. www.ipm.ucdavis.edu/PMG/crops-agriculture.html

The UC Pest Management Guidelines database supplies the University of California's official guidelines for pest monitoring techniques, pesticides, and nonpesticide alternatives for managing insect, mite, nematode, weed, and disease pests in agricultural crops, floriculture and ornamental nurseries, commercial turf, and in homes and landscapes. The guidelines are written by researchers, specialists, and farm advisors, and are updated regularly as pesticide registrations change and new methods become available.

PRINCIPLES OF VERTEBRATE PEST MANAGEMENT-Washington State University Cooperative Extension Service.
www.snohomish.wsu.edu/vertchap.htm

Excellent guide to vertebrate pest management including biology, behavior and techniques. Great site to obtain answers to your vertebrate management questions.

RISE West Nile Virus/Encephalitis Web Site Launched

WASHINGTON, D.C. — In preparation for a possible second summertime outbreak of the deadly West Nile Virus (encephalitis), Responsible Industry for a Sound Environment (RISE) has launched a Web site featuring information about the mosquito-born virus, www.pestfacts.org/media. The Web site is designed to act as a clearinghouse of information for the media and general public about West Nile Virus, public health concerns and mosquito control.

"After last year's encephalitis outbreak, it was apparent there was a need for accurate, easily accessible facts," said Allen James, executive director, RISE. "This web site fills that need and stands as a well-researched central resource from which both the media and general public can get answers to key questions, and learn about this dangerous virus."

Information on www.pestfacts.org/media includes:

- Background/History of West Virus and

(Continued on page 26)

(On the web…Continued from page 25)

encephalitis.

- How West Nile Virus is spread.
- Diagnosis and treatment of encephalitis.
- Answers to commonly asked questions.
- Mosquito control and pesticide facts.

The site also features a source list of people to contact for West Nile Virus information, as well as breaking news about West Nile Virus and encephalitis public health concerns. All information on the web site was provided by expert sources in the medical, public health and pest control fields.

"The best course of action in such a potentially explosive issue like West Nile Virus is to arm the media and the public with solid, verified information," James said. "That's what www.pestfacts.org/media is all about."

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Vector-borne Disease of the Month

Schistosomiasis

Health Information for International Travel, 1999–2000 CDC

Description

Schistosomiasis is caused by flukes whose complex life cycles involve specific fresh-water snail species as intermediate hosts. Infected snails release large numbers of minute free-swimming larvae (cercariae) that are capable of penetrating the unbroken skin of the human host. Even brief exposures to contaminated water can result in infection.

Clinical manifestations of acute infection can occur within 2–3 weeks of exposure to cercariae-infested water, but most acute infections are asymptomatic. The most common acute symptoms are fever, lack of appetite, weight loss, abdominal pain, weakness, headaches, joint and muscle pain, diarrhea, nausea, and cough. Rarely, the central nervous system can be involved to produce seizures or transverse myelitis as a result of mass lesions of the brain or spinal cord. Chronic infections can cause disease of the lung, liver, intestines, and/or bladder. Many people who develop chronic infections can recall no symptoms of acute infection. Diagnosis of infection is usually confirmed by serologic studies or by finding schistosome eggs on microscopic examination of stool and urine. Schistosome eggs may be found as soon as 6–8 weeks after exposure but are not invariably present. Bathing with contaminated fresh water can also transmit infection. Human schistosomiasis cannot be acquired by wading or swimming in salt water (oceans or seas).

Occurrence

This infection is estimated to occur worldwide among some 200 million people. The countries where schistosomiasis is most prevalent include Brazil; Egypt and most of sub-Saharan Africa; and southern China, the Philippines, and Southeast Asia.

Risk for Travelers

Exposure to schistosomiasis is a health hazard for U.S. citizens who travel to endemic areas of the Caribbean, South America, Africa, and Asia. Outbreaks of schistosomiasis have occurred among adventure travelers participating in river trips in Africa as well as resident expatriates and Peace Corps volunteers. Those at greatest risk are travelers who engage in wading or swimming in fresh water in areas where poor sanitation and appropriate snail hosts are present.

Vaccine

No vaccine is available. At this time, no available drugs are known to be effective as chemoprophylactic agents. However, safe and effective oral drugs are available for the treatment of schistosomiasis.

Preventive Measures

Since there is no practical way for the traveler to distinguish infested from noninfested water, fresh-water swimming in rural areas of endemic countries should be avoided. In such areas, heating bathing water to 50° C (122° F) for 5 minutes or treating it with iodine or chlorine in a manner similar to the precautions recommended for preparing drinking water will destroy cercariae and make the water safe. Thus, swimming in adequately chlorinated swimming pools is virtually always safe, even in endemic countries. Filtering water with paper coffee filters may also be effective in removing cercariae from bathing water. If these measures are not feasible, allowing bathing water to stand for 3 days is advisable, since cercariae rarely survive longer than 48 hours. Vigorous towel drying after accidental exposure to water has been suggested as a way to remove cercariae in the process of skin penetration. Although toweling may prevent some infections, to recommend this to travelers might give them a false sense of security; it is far safer to recommend avoiding contact with contaminated water. Upon return from foreign travel, those who may have been exposed to schistosome-infested fresh water should undergo screening tests.

PESTS OF THE MONTH

Can you identify the following beetle families?

A)

B)

C)

Parting Shots……..

That's all for now. Remember that we are here to address your pest management concerns. Give us a call at DSN 686-8122, commercial 510-337-8122 or drop us a line at paa5245@exmail.dscp.dla.mil.